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Authigenic iron-rich sediment in the Kleine Nete basin, Belgium

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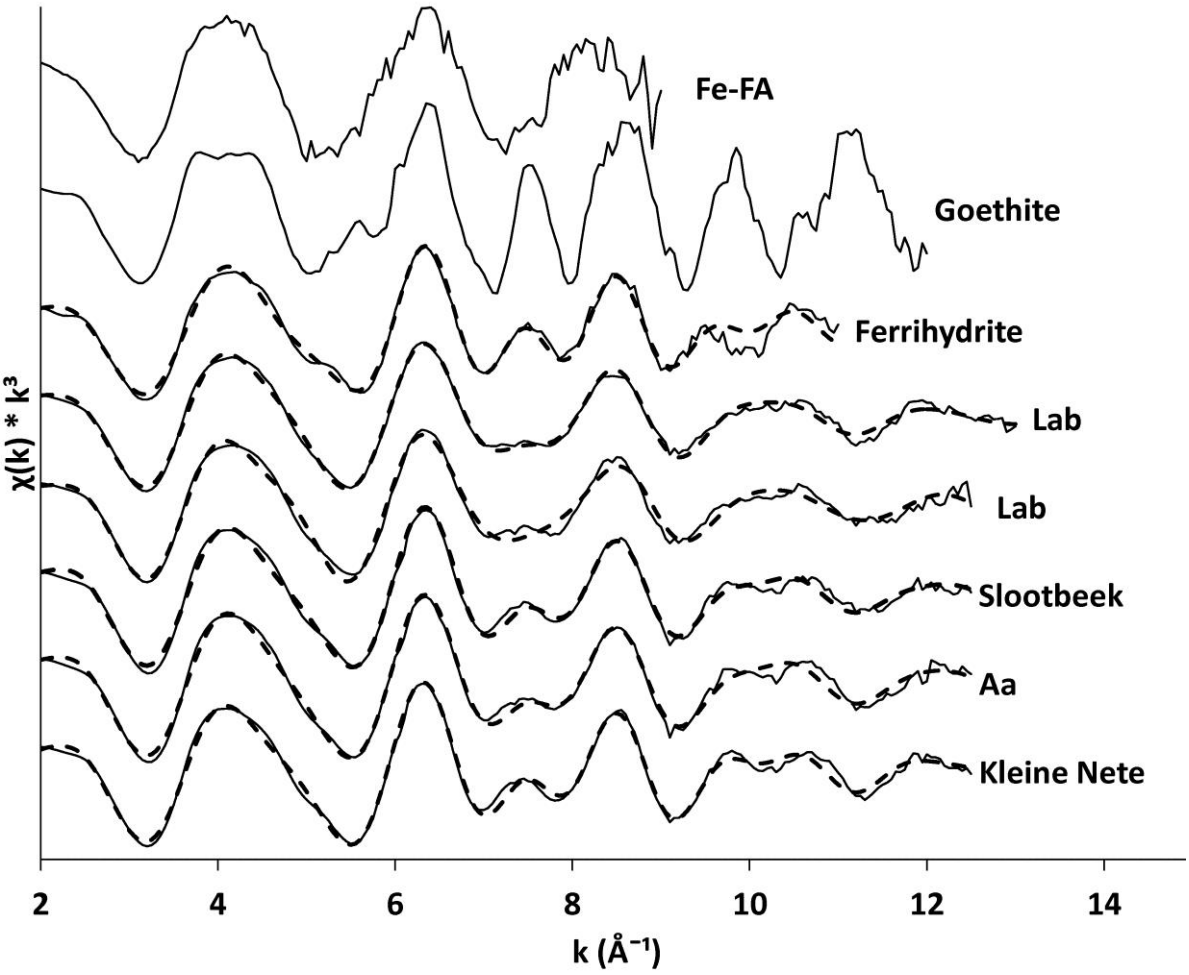
In the Kleine Nete basin (Belgium), redox processes involving iron (Fe) strongly affect suspended sediment dynamics and P geochemistry. The basin is characterised by a flat topography, highly permeable aquifers containing Fe minerals, and low and fluctuating groundwater tables. The Kleine Nete river and its tributaries are predominantly groundwater-fed. These groundwaters (pH 6.2—7.2) contain elevated Fe(II) concentrations that vary widely in space and time, roughly between 1 and 100 mg Fe(II)/L. Where such Fe-containing groundwaters surface, the Fe(II) is oxidised to Fe(III) which readily precipitates and may be transported to the receiving streams. The goal of this study was to better understand the geochemistry, the relative importance, and the implications of such authigenic Fe-rich material in the water column.

Iron was the most important constituent of the suspended sediment in the major rivers (18—25%) and in a small brook (37—40%). Other important constituents were C, Si, and P. EXAFS spectroscopy (Figure 1) showed that the Fe speciation in suspended sediment samples was much like that in ferrihydrite. The mean particle diameter was between 10 and 20 um. In oxidation experiments, nearly all Fe(II) in pre-filtered groundwaters was oxidised within 2 days, and the rate of oxidation could be reasonably well predicted by an existing model. The authigenic material produced in the lab had a smaller mean particle size (around 5 um) and was less hydrolysed than the samples from the field. The particulates produced in the lab contained, on average, 44% Fe. The freshly produced authigenic material was identified as hydrous ferric oxides, slightly less hydrolysed than ferrihydrite. As a rough estimate, between 30 and 50% of the isolated suspended material was of authigenic origin. The authigenic material strongly affects P chemistry in the Kleine Nete basin: groundwaters are rich in P but as these groundwaters surface, the P is trapped by the freshly formed authigenic material. This mechanism keeps dissolved P concentrations below the eutrophication limit. The authigenic material has also implications for waterway management due to an increased amount of dredged material. In a follow-up study, a model for authigenic sediment formation and transport will be refined based on the geochemical knowledge gained in this study.


Fe-FA
Goethite
Ferrihydrite
Lab
Lab
Slootbeek
Aa
Kleine Nete
χ(k) * k³
2
4
6
8
10
12
14
k (Å⁻¹)